CONCLUSIONS

The multidisciplinary approach to urban flood control and stormwater management problems is a comparatively recent development. Consequently, it is difficult to prescribe the most appropriate method for integrating the viewpoints of participating disciplines into a coherent problem-solving process. It is apparent that each technical area of inquiry has its own particular strengths and limitations and that none appears able to provide an exclusive solution.

The "state of the art" in hydrologic modeling has developed rapidly in recent years and has produced relatively reliable models for predicting the hydrologic response of land under various types of development. By common consent these models have become fairly standardized and routinely incorporated into floodplain management processes. However, the output from these models is only as reliable as the input data used to calibrate and verify them. In this collection of papers, VanSickle indicates the serious problems created by inadequate prediction of the hydrologic effect of urbanization.

Such reliability and common acceptance do not extend to the water quality components of stormwater models. Although the amount and quality of empirical data describing stormwater quality has increased, understanding of the underlying production and assimilation mechanism is still in an embryonic stage of development. There is a large gap between what scientists can provide and what decision-makers need.

There is no question that solutions to the stormwater management problem will require the capability to predict both quantity and quality of water as functions of various development factors. Data and relationships have only recently been developed for nonpoint sources of pollution that generate stormwater problems. As models become more reliable, various management strategies, such as on-site detention storage measures, can be simulated and tested for technical efficiency.

Geographic information systems capable of organizing large amounts of information for use in floodplain and stormwater management have increased in sophistication and have become more generally available to practicing professionals and governmental decision-makers. Many of the prob-

lems encountered earlier in handling data at various levels of resolution and in converting from one referencing system to another have been overcome, and new techniques promise further to revolutionize developments in the field.

A frequent problem arises from the traditional separation of the activity involved in creating an information system from the planning activity involved in solving specific flood control and stormwater problems. Either the development of more useful systems from a decision-making perspective, or a more conscientious interdisciplinary dialogue during all stages of system development, would go a long way to alleviate this problem. The beginnings of this dialogue were apparent during the symposium, as is seen by Davis and Webb's use of spatial data-management methods for performing comprehensive flood damage analysis.

In a similar vein, the existing capacity to store, organize, retrieve, and display data is sadly underutilized by most present-day data-gathering or monitoring programs. This does not mean that monitoring programs should be designed to conform solely to the dictates of available information-handling technologies. This of course would be foolish. Rather, it suggests that problems encountered earlier in dealing with data once they were gathered have largely been eliminated. Good examples of the use of a computerized information system for organizing and displaying complex data are presented here by Lovell and Smith in Rowlett Creek and by Rowe et al. in Cypress Creek, Texas.

In principle, anyway, there appears to be a sufficient number of existing or imaginable regulatory control mechanisms for supporting most flood control and stormwater management functions (see Blackburn's paper in this volume). But their use is often hampered by technical difficulties encountered in providing specific guidelines or performance standards for incorporation within the control mechanisms themselves. The apparent need for unambiguous technical information during a litigation process also presents problems for scientists. While the courts render "yes" and "no" decisions, the conclusions reached by scientists are apt to be "maybe" or "maybe not."

Although well developed with respect to the assessment of direct costs and benefits, the economics of stormwater management is a comparatively new area of inquiry. The overall societal costs and benefits of various management strategies remain unexplored, and determining them presents an exciting challenge. Butler and Maher argue for basin-wide management so that downstream users are protected from uncontrolled upstream developments. Bedient et al. support their findings with data on increased flooding and pollutant loadings following development in the Brays Bayou, Texas, watershed.

Finally, flood control and stormwater management have evolved from

being the almost exclusive domains of engineers and planners to becoming multidisciplinary functions involving lawyers, scientists, and concerned citizens. Dialogue between disciplines is new, although it is generally recognized that no one discipline alone can provide all the answers, as we see from the recent changes in the planning process of the U.S. Army Corps of Engineers described by Vanden Bosch. This perception is healthy and bodes well for continued interdisciplinary activity and ultimate development of more appropriate management programs than currently exist.

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